

Examiners' Amendment

[0006] The present invention provides an electrical structure, comprising:

[0007] a semiconductor device, the semiconductor device comprising a primary inverting amplifier and a ^{crystal substitution} ~~programmable~~ damping resistor; and

[0008] a crystal electrically coupled to the primary inverting amplifier, a resistance value of the ^{crystal substitution} ~~programmable~~ damping resistor being adapted to vary in order to control an amount of current flow from the primary inverting amplifier to the crystal, the amount of the current flow to the crystal being dependent upon an electrical property of the crystal.

[0009] The present invention provides a method, comprising:

[0010] providing an electrical structure comprising a semiconductor and a crystal, the semiconductor device comprising a primary inverting amplifier and a ^{crystal substitution} ~~programmable~~ damping resistor, the crystal being device electrically coupled to the primary inverting amplifier;

[0011] varying a resistance value of the ^{crystal substitution} ~~programmable~~ damping resistor in order to control an amount of current flow from the primary inverting amplifier to the crystal, the amount of the current flow to the crystal being dependent upon an electrical property of the crystal.

Examiners Amendment

crystals). The fixed value R_1 of the resistor 12 should be about equal to a capacitive reactance of the capacitor 16. The crystal oscillator circuit 2 is designed to operate with one specific design frequency value (or electrical property such as, inter alia, Q-factor, power dissipation value, etc) for the crystal Y_1 dependent upon the fixed value R_1 of the resistor 12 a fixed value R_3 of the resistor 8, a fixed value C_1 of the capacitor 16, a fixed value C_2 of the capacitor 18, and a gain of the inverting amplifier 10. A programmable oscillator circuit may be designed to operate with different crystals comprising different electrical properties such as inter alia a specific design frequency value of a crystal as described infra in the description of FIG. 2.

[0020] FIG. 2 illustrates a variation of the crystal oscillator circuit 2 of FIG. 1 showing a schematic of a programmable crystal oscillator circuit 4 comprising an inverting amplifier 19, a crystal Y_2 , capacitors 16 and 18, and a variable resistor 14, in accordance with embodiments of the present invention. The crystal Y_2 may be, inter alia, a quartz crystal. A supply voltage VDD is applied to the inverting amplifier 19. The variable resistor 14 and the crystal Y_2 are electrically connected between an output 32 of the invert-

6/7/15

WIDE RANGE CRYSTAL OSCILLATOR

Abstract

A structure and associated method to allow an oscillator circuit to operate with a plurality of different crystals. The oscillator circuit comprises a semiconductor device and a crystal. The semiconductor device comprises a primary inverting amplifier and a ^{crystal substitution} ~~programmable~~ pro- damping resistor. The crystal is electrically coupled to the primary inverting amplifier. A resistance value of the ^{crystal substitution} ~~programmable~~ pro- damping resistor is adapted to vary in order to control an amount of current flow from the primary inverting amplifier to the crystal. The amount of the current flow to the crystal is dependent upon an electrical property of the crystal.

Claims

- [c1] 1. An electrical structure, comprising:
a semiconductor device, the semiconductor device comprising a primary inverting amplifier and a ^{crystal substitution} ~~programmable~~ ^{crystal} damping resistor; and
a crystal electrically coupled to the primary inverting amplifier, a resistance value of the ^{crystal substitution} ~~programmable~~ ^{crystal} damping resistor being adapted to vary in order to control an amount of current flow from the primary inverting amplifier to the crystal, the amount of the current flow to the crystal being dependent upon electrical properties of the crystal.
- [c2] 2. The electrical structure of claim 1, further comprising a first capacitor, a second capacitor, and a second resistor, wherein a voltage gain of the primary inverting amplifier is variable, and wherein the voltage gain of the inverting amplifier is adapted to be varied dependent upon the electrical properties of the crystal, a capacitance value of the first capacitor, a capacitance value of the second capacitor, and a resistance value of the second resistor.
- [c3] 3. The electrical structure of claim 2, wherein at least

- [c9] 9. The electrical structure of claim 2, wherein the primary inverting amplifier internally comprises a plurality of secondary inverting amplifiers electrically connected in parallel, and wherein the voltage gain of the primary inverting amplifier is adapted to be varied by disabling at least one of the plurality of secondary inverting amplifiers.
- [c10] 10. The electrical structure of claim 2, wherein the primary inverting amplifier internally comprises a plurality of secondary inverting amplifiers, wherein the plurality of secondary inverting amplifiers is divided into a plurality of groups, wherein each group comprises at least two of the plurality of secondary inverting amplifiers electrically connected in parallel, and wherein the voltage gain of the primary inverting amplifier is adapted to be varied by enabling or disabling at least one of said groups.
- [c11] 11. A method, comprising:
providing an electrical structure comprising a semiconductor and a crystal, the semiconductor device comprising a primary inverting amplifier and a ^{crystal substitution} ~~programmable~~
~~damping~~ resistor, the crystal being device electrically coupled to the primary inverting amplifier;
varying a resistance value of the ^{crystal substitution} ~~programmable~~ ~~damping~~ resistor in order to control an amount of current flow from the primary inverting amplifier to the crystal, the

6/7/15

6/7/15